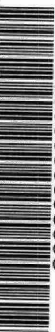
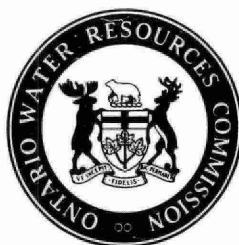


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A PREFABRICATED OXIDATION DITCH  
FOR  
PILOT SCALE STUDIES

DIVISION OF RESEARCH  
ONTARIO WATER RESOURCES COMMISSION

January, 1968

R.P. 2014

*Filing Cabinet*

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*J. J. Williams*  
**ONTARIO WATER RESOURCES COMMISSION**

**INTER-OFFICE MEMORANDUM**

DATE April 4, 1968

TO General Manager, Assistant General Managers, Directors and Supervisors

FROM A. J. Harris, Director

Division of Research

RE: RESEARCH PAPER NO. 2014

Enclosed is a copy of our Research Paper No. 2014, "A Prefabricated Oxidation Ditch for Pilot Scale Studies" prepared by S. A. Black.

This pilot plant may be used for investigating the treatment of any waste where the oxidation ditch process is being considered. This paper describes and presents data of the operation of the pilot plant as it was initially used to treat domestic sewage. At the present time this unit is being used by the Division of Research to study the treatment of animal wastes.

AJH:nm

Encl.

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A PREFABRICATED OXIDATION DITCH  
FOR  
PILOT SCALE STUDIES

By:

S. A. Black

January, 1968

Division of Research  
Paper No. 2014

A. J. Harris  
Director

Dr. J. A. Vance  
Chairman

D. S. Caverly  
General Manager

The Ontario Water Resources Commission

## SUMMARY

A pilot oxidation ditch has been designed by the Applied Sciences Branch, Division of Research for use in evaluating the oxidation ditch process as a means for treating farm animal wastes. This prefabricated ditch, costing less than \$1,000 (excluding rotor) may be used as a pilot plant for investigating the treatment of any waste where the oxidation ditch process is being considered. It can easily be dismantled, moved and reassembled for in-location studies.

This paper describes and presents data of the operation of the pilot plant as it was initially used to treat domestic sewage. The data presented will be used as reference for future studies with the pilot oxidation ditch.

## INTRODUCTION

Since its development in the 1950's, by the Institute of Public Health Engineering T.N.O. in the Netherlands, the oxidation ditch process of sewage treatment has received world-wide attention. Consisting basically of facilities to provide a) retention of the waste, b) aeration and mixing of the waste and mixed liquor and c) separation of sludge solids from the liquid effluent, the oxidation ditch provides a high-purification capacity, and is a reliable and economical means of sewage treatment for small communities. Many seasonal industries, such as fruit and vegetable canning, have found the oxidation ditch to be an economical and adequate treatment process for their wastes.

Recently, several organizations have become interested in the oxidation ditch as a facility for treating farm animal wastes because of the simplicity, low capital investment and high purification capacity of the process. If its ability to effectively treat farm animal wastes can be established, it would appear to be an ideal process for large farming operations where waste treatment is required.

In order to supplement its field observations of actual farm installations of the oxidation ditch process, the Applied Sciences Branch, Division of Research, OWRC, has designed a pilot oxidation ditch to evaluate and determine operating parameters of the oxidation ditch as a facility for treating farm animal wastes. Because of its small scale, one month's operation of the pilot ditch may produce information that would require one year's operation of a full scale installation.

Before being used on farm animal wastes, the pilot plant was fed with domestic sewage in order to determine its operating characteristics on a known waste and to gain experience in the use of the ditch.

The purpose of this paper is to describe the pilot plant facility and to present operational data obtained from the treatment of domestic sewage. The data presented will be used for comparison purposes for future studies of the pilot ditch with farm animal wastes.

### PILOT OXIDATION DITCH FACILITY

The pilot oxidation ditch was prefabricated from 10-gauge galvanized steel sheeting formed into troughs, 42 inches long by 48 inches wide by 48 inches high. Twelve of these sections were prepared with holes for bolting the sections together. Two end plates, also of 10-gauge galvanized steel were prepared. Eight 4- by 8-foot sheets of 12-gauge galvanized steel were obtained to be used as a center divider running the length of the ditch and for preparing rounded end baffles. The total cost of the 96 foot ditch was in the order of \$900. Only four sections of the ditch were used in this study, as it was carried out in the laboratory building. A diagram of the pilot ditch, as used, is shown in Figure 1.

Ordinarily, an oxidation ditch is operated either on a fill and draw basis to allow settling of the sludge and withdrawal of supernatant, or with a separate settling tank, complete with sludge return, set up adjacent to the ditch. For this study, in order to simplify the facility as much as possible, settling of the mixed liquor was provided behind one of the end baffles which was raised to permit entry of the mixed liquor and return of the settled sludge. Effluent was drawn off from the settling section by a constant head overflow pipe.

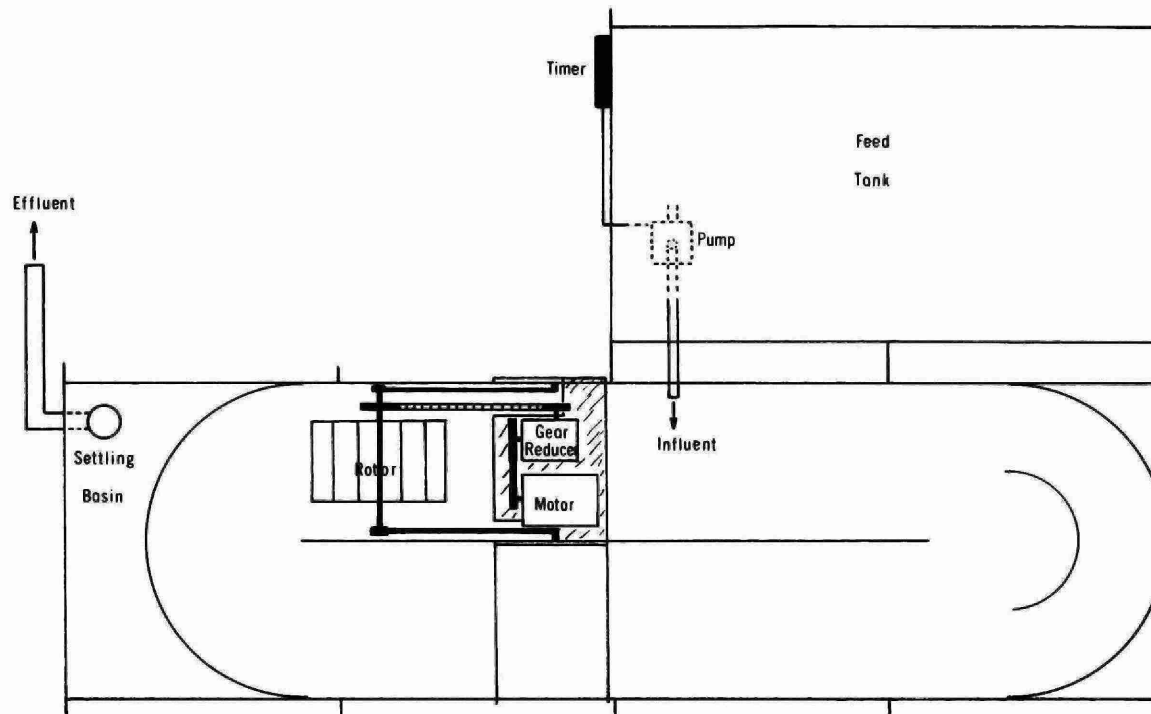


Figure 1 — Pilot Oxidation Ditch

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SCALE: 1" = 2'

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The rotor used with this ditch is of steel plate construction and is 12 inches wide by 20 inches in diameter with 12 rows of 5-inch long by 3/4-inch wide teeth. It is run by a 1.5 HP electric motor through a gear reducer and chain drive. By exchanging sprockets and pulleys, a wide range of rotating speeds is possible. The complete unit is suspended from the top of the ditch and the rotor is adjustable through the full depth of the ditch.

Views of the aeration rotor and the ditch in operation are presented in Figures 2 and 3.

Feed for the pilot oxidation ditch was collected in a feed tank made from two of the trough sections with plywood ends. A submersible pump and 24-hour cycle timer was used to pump the feed into the ditch at a pre-determined rate. Feed entered the ditch at a point just behind the brush.

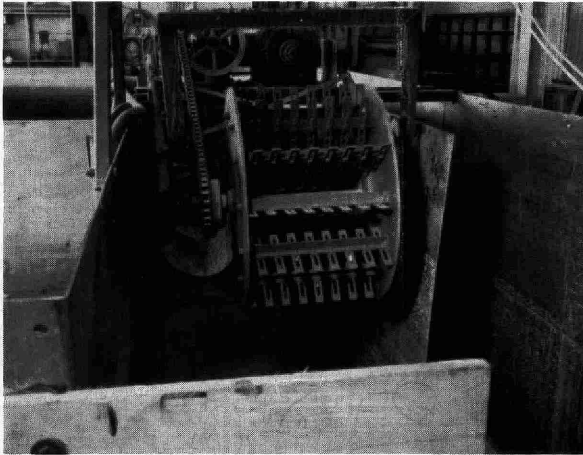


Figure 2 - Aeration Rotor Installed in the Pilot Oxidation Ditch



Figure 3 - Pilot Oxidation Ditch in Operation

### STUDY METHOD

Thirty gallons of activated sludge from a local sewage treatment plant were mixed with enough raw sewage to bring the level of the ditch to the two foot overflow height. This gave a volume of 540 gallons (Imp) in the ditch section and 72 gallons in the settling section. The aerator was operated for two days before the feed tank was filled and feed was pumped into the ditch. A mixer installed in the feed tank maintained the settleable solids in suspension without producing any aeration effects. Raw sewage was added to the ditch at a rate such as to give 24-hours detention.

Oxygen utilization rate determinations indicated an active mixed liquor by the fifth day of operation, but it was not until after 12 days of operation that the oxygen utilization rate reached 12 ppm/hr. Detention time was then decreased to 12 hours and daily sampling was begun.

Samples were taken and analyzed for BOD, COD, Total, Suspended and Dissolved Solids and Volatile Suspended Solids. Samples of mixed liquor were also collected for analyses of Suspended and Volatile Suspended Solids. All analyses were made according to Standard Methods. Oxygen utilization rate determinations were continued on the mixed liquor in order to follow the activity of the microorganisms.

Sampling at 12-hours detention was carried out over a 10-day period at which time a small tube settler was installed in the ditch and the flow was decreased considerably.

The tube settler was constructed of ten,  $2\frac{1}{2}$ -foot, 2-inch diameter copper tubes connected, at  $60^\circ$  to the horizontal, to a common overflow trough. The tubes had a total opening area of 0.218 sq ft and a volume of 4.0 gallons. Various flow rates were used to establish the capacity of the settler.

### BRUSH OXYGENATION CAPACITY

Prior to this study, oxygenation capacity (oxygen transfer rate) determinations were made on the brush at three immersion depths in tap water. Sodium sulfite with a cobalt catalyst was used to reduce the dissolved oxygen to zero for the tests. At immersion depths of 3, 5 3/4 and 8 inches and a brush speed of 68 rpm, transfer rates were found to be 4.85, 6.50 and 7.87 lb O<sub>2</sub>/day, respectively. At 95 rpm, transfer rates were increased to 8.6, 12.0 and 14.8 lb O<sub>2</sub>/day, respectively, and at a brush speed of 120 rpm, transfer rates were increased further to 13.0, 19.2 and 24.1 lb O<sub>2</sub>/day, respectively.

Since the power consumed in brush aeration varies as the 2.8th power of the brush speed but only directly as the brush immersion, it is more economical to use brush immersion as a means of varying the aeration intensity where possible.

The curves of Figure 4 give the oxygenation capacity of the brush at speeds of 68, 95 and 120 rpm and immersion depths between 3 and 8 inches. These graphs may be used to obtain the optimum combination of speed and immersion for the waste being considered.

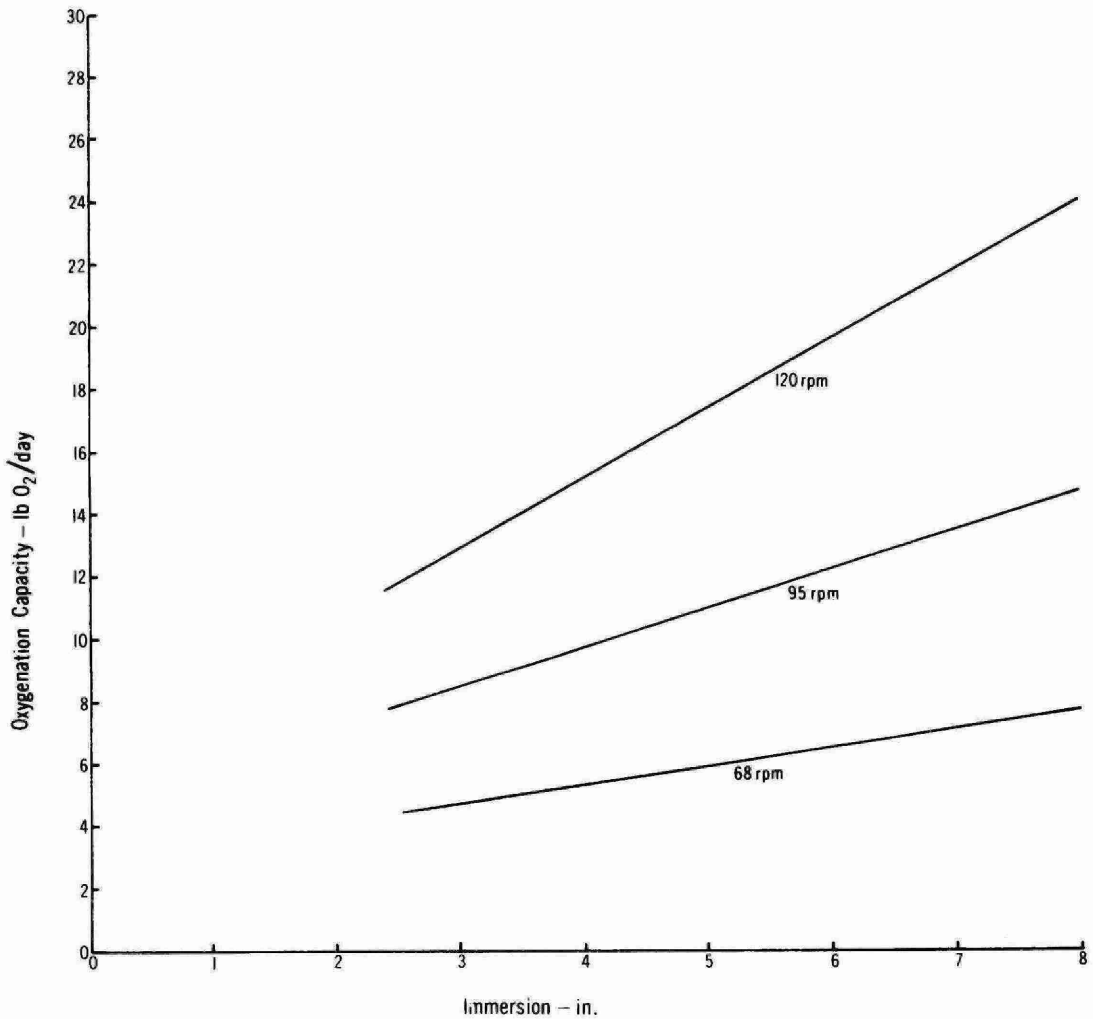


Figure 4 - Oxygenation Capacity vs. Immersion at various Brush Speeds

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In the case of this study, samples of the domestic sewage indicated a BOD strength in the order of 300 ppm. Assuming that 1.4 lb oxygen is required to stabilize 1.0 lb of BOD, at 12-hr detention, the oxygenation capacity required by the brush would be  $1.4 \times \frac{300}{1,000,000} \times 5,400 \times 2 = 4.5 \text{ lbs } O_2/\text{day}$ . It was therefore decided that the 68 rpm at 3 inches immersion combination would be used for this study.

### OPERATIONAL RESULTS

An active biological sludge was established in the oxidation ditch after 10 days of operation at 24-hours detention. Microscopic examination over this 10-day period revealed a progressive increase in the numbers of Vorticella spp. of bacteria in the mixed liquor, a high concentration of Vorticella spp. being indicative of a healthy aerobic sludge. Oxygen utilization rate determinations over this period also revealed an increase in biological activity.

Table 1 presents high, low and average values as well as percent reductions of BOD, COD and Suspended Solids. As can be seen, a wide variation of influent and effluent quality occurred throughout the study period. Treatment efficiencies, as indicated by BOD and Suspended Solids removal, were high for this process although effluent concentrations were somewhat above Commission objectives of 15 ppm BOD and SS.

TABLE 1

PILOT OXIDATION DITCH OPERATIONAL DATA

	BOD		COD		SS	
	<u>In</u>	<u>Out</u>	<u>In</u>	<u>Out</u>	<u>In</u>	<u>Out</u>
High (ppm)	530	48	1780	185	1356	58
Low (ppm)	122	12	290	85	98	15
Avg. (ppm)	288	24	877	124	603	28
Redn. (%)	92		86		95	

Loadings to the ditch reached a maximum of 57 lbs BOD/1,000 cu ft/day and averaged 31.3 lbs BOD/1,000 cu ft/day or <sup>0.25</sup>~~2.9~~ lbs BOD/lb MLSS/day at a MLSS concentration of 2,000 ppm.

The MLSS concentration carried in the pilot ditch was quite low compared to the 4,000 ppm normally carried in this process. Solids were found to build up in the settling section and behind the rounded end baffles and had to be occasionally pumped back to the ditch to keep them from turning septic. It had been thought that the circular flow pattern in the aeration ditch would prevent sludge from accumulating in the settling section but such was not the case.

As a result of preliminary trials with a small tube settler, a larger settler has now been designed for installation within the ditch, which, it is hoped, will overcome the settling problem. If not, a separate settling tube with sludge return facilities will be designed.

### DISCUSSION

The pilot oxidation ditch was able to effectively treat domestic sewage at a loading of 31 lb BOD/1,000 cu ft/day, at a MLSS content of 2,000 ppm and detention of 12 hours. Efficiencies of BOD and SS removal in excess of 90% were achieved.

As a result of this preliminary study, it was decided that a different approach would have to be made in regards to solids-liquid separation. A tube settler installed in the ditch accomplished good settling at a surface flow rate of just over 1 gal/min/sq ft and detention of 17 minutes. A tube settler with three times the capacity of this settler has been designed for future studies with the pilot oxidation ditch.

This study was successful in that it proved the basic design of the pilot oxidation ditch and provided operational data and experience for future pilot studies with the ditch.